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A Model of U.S. Corn, Sorghum, and Soybean Markets and the Role of Government Programs (USAGMKTS)

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This estimated model of corn, sorghum, and soybeans markets (USAGMKTS) serves as the U.S. agricultural sector in a study of the effects of U.S. agriculture and macroeconomic policy on Mexico's agricultural sector.

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This paper — a product of the Agricultural Policies Division, Agriculture and Rural Development Department — is part of a larger effort in PRE to understand the dependence of domestic agricultural markets on domestic macroeconomic policy and the macroeconomic and trade policies of major trading partners. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Cicely Spooner, room N8-035, extension 30464 (42 pages with tables).

This model of U.S. corn, sorghum, and soybeans markets also includes U.S. markets for beef, hogs, and poultry — because of their importance and endogeneity with respect to U.S. feed grain policies, which are major determinants of corn and sorghum prices.

The model is part of a set of interlinked sectoral and macroeconomic models that link Mexico and the United States (with enough specification for the rest of the world to close the system).

Just reports the results of the simulations of various alternative U.S. agricultural policy scenarios, to estimate the effects of various feed grain policy instruments.

Plausible U.S. agricultural policy adjustments can alter border prices facing world trading partners by 10 to 15 percent. The extent of these adjustments depends heavily on the current state of the U.S. agricultural economy — and they are transmitted to other grain and livestock markets in varying degrees.

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**A Model of U.S. Corn, Sorghum, and Soybean Markets
and the Role of Government Programs (USAGMKTS)**

**by
Richard E. Just**

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A MODEL OF U.S. CORN, SORGHUM, AND SOYBEAN MARKETS AND THE ROLE OF GOVERNMENT PROGRAMS (USAGMKTS)

Introduction

This report describes an estimated model of corn, sorghum, and soybeans (USAGMKTS) which serves as the U.S. agricultural sector in a study of the effects of U.S. agricultural and macroeconomic policy on Mexico's agricultural sector. The model also includes U.S. markets for beef, hogs, and poultry because of their importance and endogeneity with respect to U.S. feed grain policies which are major determinants of U.S. corn and sorghum prices. The model USAGMKTS is a member of a set of interlinked models at macroeconomic and sectoral levels of Mexico and the U.S. (and enough specification of the rest of the world to close the system). The Mexican agricultural model is discussed in the companion report by O'Mara and Ingco (1989). The U.S. macroeconomic model is the FAIRMODEL developed by Fair (1984).

Overview of the Model

The grain demand component of the USAGMKTS model disaggregates demands by consumption, market inventory, and exports following the specifications of Just and Chambers (1981). Demand for government stocks and the farmer owned reserve follows the work of Rausser (1985) and Love (1987) with somewhat more structure to reflect the qualitative nature of policy instruments. The livestock component follows along lines used by Just (1981) with revisions to incorporate some refinements developed by Rausser and Love. The grain supply model uses logit equations to represent program participation decisions following the spirit of the work by Chambers and Foster (1983) and later empiricized by Rausser and Love. The acreage equations depart significantly from previous econometric practice and incorporate more structure among important program and market variables in the spirit of the intuitive and

conceptual framework developed by Gardner (1988) and Lins (1988). They examine the gains and losses associated with the wheat and corn programs by means of a quantitative graphical analysis of the various policy instruments through which wheat and feed grain commodity policies are administered. The crop supply models are estimated using annual data while the crop demand models and meat supply and demand models are estimated using quarterly data.

The Crop Supply Structure

The basic form of the acreage equations is as follows. First, acreage in a market free of government programs is assumed to follow

$$(1) \quad A_f = A_f(\pi_n, \pi_a, A_{f,-1})$$

where

A_f = free market acreage of the crop in question

π_n = anticipated short-run profit per acre from production of the crop
in question with free market price

π_a = anticipated short-run profit per acre from production of competing
crop(s)

$A_{f,-1}$ = lagged free market acreage (to represent production fixities,
etc.).

Profit per acre is defined by price times yield less per acre production cost,
e.g.,

$$(2) \quad \pi_n = P_m Y_a - C$$

where

P_m = market price

Y_a = expected yield

C = short-run cost per acre.

When government programs are voluntary, the nonparticipating component of acreage is assumed to follow equation (1) on the nonparticipating proportion of the acreage so nonparticipating acreage is

$$(3) \quad A_n = (1 - \phi) A_f(\pi_n, \pi_a, A_{f,-1})$$

where

A_n = nonparticipating acreage

ϕ = rate of participation in the relevant government program.

The participating acreage is largely determined by program limitations with

$$(4) \quad A_p = B \phi (1 - \theta) - D(G_a)$$

where

B = program base acreage

θ = minimum diversion requirement for participation

D = additional diversion beyond the minimum

G_a = payment per acre for additional diversion.

The estimating equation for observed total acreage given the participation level is obtained by combining (3) and (4),

$$(5) \quad A_t = B \phi (1 - \theta) - D(G_a) + (1 - \phi) A_f(\pi_n, \pi_a, A_{f,-1}),$$

where $D(\cdot)$ and $A_f(\cdot)$ follow linear specifications.

Determining the level of participation in this framework is crucial. Each farmer is assumed to participate if his/her perceived profit per acre is greater under participation than under nonparticipation ($\pi_p^i > \pi_n^i$). Assuming that individual perceived profits differ from an aggregate by an amount characterized by an appropriate random distribution across farmers, the participation rate can be represented by a logistic relationship with

$$(6) \quad \ln \frac{\phi}{1-\phi} = \phi^*(\pi_n, \pi_p)$$

where

π_p = the profit per acre under compliance.

Given the qualitative nature of numerous agricultural policy instruments, a conceptually plausible specification of short-run profit per unit of land (producing plus diverted) on complying farms follows

$$(7) \quad \pi_p = (1 - \theta - \mu)\pi_z + \theta \cdot G_m + \mu \cdot \max(G_v, \pi_p)$$

where μ is the maximum proportion of base acreage that can be diverted in addition to minimum diversion, G_m is the payment per unit of land for minimum diversion (zero is no payment is offered for minimum diversion), G_v is the payment per unit of land for voluntary diversion beyond the minimum, and π_z is the short-run profit per unit of producing land under compliance. The latter term suggests no voluntary additional diversion if $G_v < \pi_z$ and voluntary additional diversion to the maximum if $G_v > \pi_z$.

Conceptually, π_z follows

$$(8) \quad \pi_z = [\max(P_t, P_m) \cdot Y_p + \max(P_s, P_m) \cdot \max(Y_a - Y_p, 0) + \max(r_m - r_g, 0) \cdot P_s \cdot Y_a - C]$$

where P_t is the government target price, Y_p is the program yield, P_s is the price support, r_m is the market rate of interest, and r_g is the government subsidized rate of interest on commodity loans under the program (Love).

Equation (8) reflects the complicated relationship through which a participating farmer is entitled to at least the target price on his program yield, at least the (lower) support price on all of his production, and gains an additional interest subsidy on a loan against his stored crop (at harvest time) evaluated at the support price. These benefits must be balanced against the opportunity loss of having to divert some of land from production reflected by equation (7).

Once acreage is determined in this framework, it is simply multiplied by yield and added to carryin to determine crop supply. Of course, the relationships in (7) and (8) do not necessarily apply exactly. For example,

an uncertain anticipated market price may be discounted by a farmer compared to a target or support price which is known with certainty at the time of acreage decisions. Also, not all farmers place their crop under federal loan to take advantage of the interest subsidy. Nevertheless, intuition and experience implies that equations (7) and (8) apply as reasonable approximations and, furthermore, the approximations apply in a global sense. By comparison, the large number of variables with numerous qualitative relationships involved in these relationships suggests significant problems with objective econometric identification of functional form and makes the possibility of obtaining even plausible signs remote with estimation of ad hoc or flexible forms.

To illustrate the difference in performance of the approach of simply adding p and G to equation (1),

$$(9) \quad A_f = A_f(\pi_n, \pi_p, \pi_a, A_{f,-1}, G_v)$$

compared to that in equations (5) and (6), both were used to estimate acreage response of feed grains in the U.S. over the period 1962 to 1982 and then to forecast acreage in the 1983-1986 period. The results are given in Table 1. The results for equation (5) take the participation rate as exogenous whereas the results where the model is specified as equations (5) and (6) include forecasting errors for the participation rate as well.

The ad hoc formulation leads to a much smaller standard error in the sample period than the structural form in (5) even though the structural form performs better than the ad hoc form in ex ante forecasting of the post-sample period. The model combining equations (5) and (6) obtains an even lower standard error.

This superior performance of the structural model carries through when errors in forecasting the participation rate are also considered. The reason

the structural form can outperform the ad hoc model even in the sample period is that nonlinearities and kinks in response over a wide range of policy parameters put a premium on global properties of the function. The participation rate over the sample period ranges from zero (a kink point) to near 90 percent in others. As a result, the effects of profits with and without compliance cannot be well represented by a smooth approximating function.

The Crop Demand Structure

Following numerous previous studies, the demand for crops is broken into food, feed, export, and inventory components for purposes of specification and estimation of a quarterly model. The inventory component is further broken into farmer owned reserve, government owned, and market components for crops with government programs. The demand system for a given crop is thus of the form

$$\begin{aligned}
 Q_i &= Q_i(P_m, X_i), & X_i &= \{Q_{i,-1}, Y_c, T_j\} \\
 Q_f &= Q_f(P_m, X_f), & X_f &= \{Q_{f,-1}, F_j, P_j, T_j\} \\
 Q_x &= Q_x(P_m, X_x), & X_x &= \{Q_{x,-1}, E, T_j\} \\
 (10) \quad Q_r &= Q_r(P_m, X_r), & X_r &= \{Q_{r,-1}, P_s, P_r, r_m - r_g, D, T_j\} \\
 Q_g &= Q_g(P_m, X_g), & X_g &= \{Q_{g,-1}, P_s, D, T_j\} \\
 Q_m &= Q_m(P_m, X_m), & X_m &= \{Q_{m,-1}, Q_r, Q_g, r_m, D, T_j\} \\
 Q_{r,t-1} + Q_{g,t-1} + Q_{m,t-1} + A_t \cdot Y_a &= Q_i + Q_f + Q_x + Q_r + Q_g + Q_m
 \end{aligned}$$

including the supply-demand identity where

- Q_z = quantity demanded (i = industry or food, f = feed x = export,
- r = farmer owned reserve, g = government stocks, m = market stocks)
- P_m = market price
- X_z = exogenous variables which determine the relevant demand
- Y_a = actual average yield

Y_c = per capita consumer income

T_j = quarterly shift terms

F_j = numbers of various types of livestock on feed

P_j = prices of various types of livestock meat

E = trade weighted exchange rate

P_s = support price

P_r = release price

D = shift term reflecting the 1983 PIK program.

The demand system was not estimated in the form of (10) because a system that determines price through an identity equation tends to produce erratic price estimates particularly when demands are inelastic. Alternatively, a demand equation in (10) can be solved for price,

$$(11) P_m = Q_i^{-1} Q_i(X_i),$$

and then the identity can be used to determine Q_i . This approach suffers in practice because the coefficient estimates of exogenous variables in the inverted equation are susceptible to spurious correlations with other factors in the system. This can lead to an unreasonably large contribution of these variables relative to other exogenous variables in the system in determining price predictions in practice. The approach used in this study is to solve the system in (10) for a partial reduced form price equation which is then used to replace one of the demand equations in (10). This partial reduced form equation can be regarded as a convex combination of equations such as (11) which essentially produces a composite price forecasting equation in the sense of Johnson and Rausser (1982) where the weights are estimated simultaneously with the coefficients of the price equation. The number of such equations to combine in this manner is roughly determined by the tradeoff between increased forecasting accuracy of combining more forecasting equations

and reduced identification as the total number of variables in the composite forecasting equation increases.

To capture the qualitative nature of government market involvement on the demand side, the government inventory demand equation is estimated including a qualitative relationship between market and support price. For example, the government inventory demand for feed grains equation is of the form

$$Q_g = Q_g(\max(0, (P_s - P_m)\phi), Q_{g,-1}, D, T_j).$$

This equation captures the qualitative relationship whereby stocks are not turned over to the government until the market price falls to the government support level but are increasingly turned over as the market price falls below the support (note that only grain produced under voluntary compliance with the program is supported so the market price can fall below the support price). Here the qualitative price variable is highly significant (t-ratio of 7.77 for government stocks of feed grains) as compared to standard cases where a continuous function of market and support prices is used as a term explaining government stocks (see, e.g., Rausser, 1985, where the price term is a ratio of support price to market price and an implicit t-ratio of 1.48 is obtained in an otherwise similar equation).

The Livestock Supply Structure

The supply of livestock accounts for the dynamic nature of breeding herd adjustment and the long lags in breeding and raising livestock to market weight. The basic form of the model for each species is as follows. First, a stock equation is included for the size of the national breeding herd of the form

$$(12) H_i = H_i(P_c/P_i, H_{i,-1}, x_m, T_j)$$

where H_i is herd size for species i (e.g., i = cattle), P_c is the price of corn, P_i is the price of meat from species i (e.g., beef for i = cattle), and T_j represents quarterly shift terms. Next, an equation is included for numbers on feed of the form

$$(13) F_i = F_i(H_i, -k, P_c/P_i, T_j)$$

where k is the number of quarters required to reach feeding age in species i . Finally, a meat production equation is included of the form

$$(14) M_i = M_i(F_i, H_i - H_{i,-1}, P_c/P_i, r_m, T_j)$$

where M_i is the production of meat from species i . The term $H_i - H_{i,-1}$ is included to capture the addition to meat production caused by culling breeding herds.

The livestock production model consists of a set of equations similar to (12)-(14) for cattle, hogs, and poultry.

The Meat Demand Structure

The meat demand system is considered independently of the crop demand systems since meats and grains are not very closely related except as grain prices affect meat supply. Each demand equation is estimated in price dependent form with

$$P_i/Y = P_i(P_j/Y_c, P_o/Y_c, C_i/N, T_j)$$

where Y is per capita income, P_j represents prices of other meats (included individually), P_o is a price index for non-farm prices, C_i is domestic consumption of meat i , and N is population. The meat demand system is completed by net import/export equations of the form

$$I_i = I_i(P_i, I_i, -1, E, T_j)$$

where I_i is net imports (negative for net exports) and E is a trade weighted exchange rate and identities of the form

$$M_i + I_i = C_i.$$

Definitions of Variables used in the USAGMKTS Model

The data used in the USAGMKTS model can be divided into two broad groups -- annual and quarterly. The annual data is used in the estimation of the annual crop supply equations and the quarterly data is used in the estimation of crop demand, livestock supply and demand, and the exchange rate equations. Data were collected from government publications and contacts and data used in the FAIRMODEL of the macroeconomy (to facilitate linkage) with remaining variables computed as transformations of these data.

The definitions of basic variables with annual data used in the econometric work (in alphabetical order along with sources) are as follows:

- AC = Acreage of corn in million acres (*Feed: Outlook & Situation Report*)
- ACGS = Acreage of corn and grain sorghum (computed from AC and AGS)
- ACGSN = Corn and grain sorghum acreage on noncomplying farms (computed from ACGS, BACGS, COMPFGA, and DRFG)
- AGS = Acreage of grain sorghum in million acres (*Feed: Outlook & Situation Report*)
- AS = Acreage of soybeans in million acres (*Oil Crops: Outlook & Situation Report*)
- BAC = Base acreage of corn in million acres (*Feed: Outlook & Situation Report, text of various issues*)
- BACGS = Base acreage for corn and grain sorghum (computed from BAC and BAGS)
- BAGS = Base acreage of grain sorghum in million acres (*Feed: Outlook & Situation Report, text of various issues*)
- BVDPC = Real inducement for additional voluntary diversion (computed from VDPC, VDFG, BACGS, and GNPD)
- COMPFGA = Program participation rate for corn & grain sorghum in percent of acreage (U.S. Agricultural Stabilization and Conservation Service)
- COSTC = Variable costs per acre of corn in dollars (includes seed, chemicals and labor) (USDA, ESCS, Paul Gallagher, "Costs of Producing Selected Crops in the U.S.")
- COSTCGS = Variable costs per acre for corn and grain sorghum in dollars per acre (computed from COSTC, AC, COSTGS, AGS, and ACGS)
- COSTGS = Variable costs per acre of sorghum in dollars (includes seed, chemicals & labor) (USDA, ESCS, Paul Gallagher, "Costs of Producing Selected Crops in the U.S.")
- COSTS = Variable costs per acre of soybeans in dollars (includes seed, chemicals & labor) (USDA, ESCS, Paul Gallagher, "Costs of Producing Selected Crops in the U.S.")
- D70 = Dummy variable, 1 if 1970, 0 if not
- D71 = Dummy variable, 1 if 1971, 0 if not
- D72 = Dummy variable, 1 if 1972, 0 if not
- D73 = Dummy variable, 1 if 1973, 0 if not

D74 = Dummy variable, 1 if 1974, 0 if not
 DIV = Minimum feed grain diversion acreage (computed from COMPFGA, DRFG, and BACGS)
 DPC = Diversion payment for corn (paid diversion) in dollars per acre (Feed: Outlook & Situation Report, text of various issues)
 DRFG = Diversion requirement of feed grains in percent of base acreage (Feed: Outlook & Situation Report, text of various issues)
 EYLDCGS = Expected yield for corn and grain sorghum (computed from lagged values of YLDCGS)
 EYLDS = Expected yield for soybeans (computed from lagged values of YLDS)
 ICCCA = Interest charged on CCC non-recourse loans in percent (Wheat & Feed: Outlook & Situation Report, text of various issues)
 LCOMPFGA = Linearized logistic representation of the feed grain program participation rate (computed from COMPFGA)
 MAXRATE = Interest rate subsidy on stocks under CCC loan (computed from RS and ICCCA)
 MAXYLDFG = Expected corn/grain sorghum yield eligible for price support (computed from EYLDCGS and YLDFGP)
 MSPC = Effective farm price for corn/grain sorghum including price support payments (computed from SPRCA and PAFCl)
 MTPC = Effective farm price for corn/grain sorghum including deficiency payments (computed from TPC and PAFCl)
 NON = Program nonparticipation rate for corn and grain sorghum (computed from COMPFGA)
 NONLAGA = Hypothetical lagged acreage of corn and grain sorghum that would occur with no program (computed from ACGS, DIV, and COMPFGA)
 NONPROFC = Real quasirent per acre for corn and grain sorghum without participation adjusted to by percent of noncompliance (computed from PROFFGN and COMPFGA)
 NONPROFS = Real quasirent per acre for soybeans adjusted by percent of noncompliance (computed from PROFS and COMPFGA)
 NOPROG = Dummy variable, 1 if a program is in effect, 0 if not
 PAFCl = Corn, price at farm, U.S. average in dollars per bushel, January-March (Feed: Outlook & Situation Report)
 PAFS1 = Soybeans, price at farm, U.S. average in dollars per bushel January-March (Oil Crops: Outlook & Situation Report)
 PROFFG = Average real quasirent per acre among all farms for feed grains (computed from COMPFGA, PROFFGN, and PROFFGC)
 PROFFGC = Average real quasirent per acre on farms participating in the feed grain program (computed from DRFG, VDFG, RETFGP, RVOL, DPC, and GNPd) PROFFGN = Real quasirent per acre for corn/grain sorghum without participation (computed from PAFCl, EYLDCGS, COSTCGS, and GNPd)
 PROFS = Real quasirent per acre for soybeans (computed from PAFS1, EYLDS, COSTS, and GNPd)
 RATIO = Ratio of quasirent per acre on feed grain to soybeans (computed from PROFFG and PROFS)
 RCOSTCGS = Real variable costs per acre for corn and grain sorghum (computed from COSTCGS and GNPd)
 RCOSTS = Real variable costs per acre for soybeans (computed from COSTS and GNPd)
 RETFGP = Quasirent per acre for corn/grain sorghum acreage in production under participation (computed from MTPC, YLDFGP, MSPC, MAXYLDFG, MAXRATE, SPRCA, EYLDCGS, and COSTCGS)

RVOL = Maximum return on acreage eligible for additional voluntary participation (computed from VDPC and RETFGP)
 SPRC = Support price of corn in dollars per bushel (Feed: Outlook & Situation Report)
 TPC = Target price of corn in dollars per bushel (support price and additional support payment prior to 1973) (U.S. Corn Industry)
 VDFG = Additional voluntary paid diversion for feed grains in percent of base acreage (Feed: Outlook & Situation Report, text of various issues)
 VDPC = Additional voluntary diversion payment for corn in dollars per acre (Feed: Outlook & Situation Report, text of various issues)
 YEAR = Two digit year
 YLDCGS = Yield per planted acre of corn and grain sorghum in bushels per acre (calculated from acreage and production in Feed: Outlook & Situation Report)
 YLDFGP = Program yield of feed grains (corn & grain sorghum) in bushels per acre (Feed: Outlook & Situation Report, text of various issues)
 YLDS = Yield per planted acre of soybeans in bushels per acre (from acreage and production in Oil Crops: Outlook & Situation Report)

The definitions of basic variables with quarterly data used in the econometric work (in alphabetical order) are as follows:

BRCH = Broiler-type chicks hatched, millions (Livestock & Poultry: Outlook & Situation Report) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December
 BRHOGKE = Breeding hog inventory for 10-states, 1,000 head, (Livestock & Poultry: Outlook & Situation Report, Mar, May, Jul, Oct) Q1 = March 1, Q2 = June 1, Q3 = September 1, Q4 = December 1
 BROF = Broilers on feed (computed from BRCH)
 CATPL = Cattle placed on feed in 13-states, 1,000 head (Livestock & Poultry: Outlook & Situation Report, Mar, May, Aug, Dec) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December
 CBRHOGKE = Quarterly change in breeding hog inventory (computed from BRHOGKE)
 CCOWKE = Quarterly change in cattle breeding herd size (computed from TCOWKE)
 COF = Cattle on feed in 13-states, 1,000 head (Livestock & Poultry: Outlook & Situation Report, Mar, May, Aug, Dec) Q1 = January 1, Q2 = April 1, Q3 = July 1, Q4 = October 1
 COMFPG = Program participation of corn and grain sorghum in percent of acreage (U.S. Agricultural Stabilization and Conservation Service)
 CPL = Pullet chicks placed in broiler hatchery supply flocks in thousands (Livestock & Poultry: Outlook & Situation Report) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December
 CRUSH = U.S. crushings of soybeans, million metric tons
 DDFG = U.S. total domestic use of feed grains (corn, sorghum, oats, barley), million metric tons (Feed: Outlook and Situation Report)
 DDINDFG = Annual change in U.S. industry use of feed grain (computed from DINDFG)
 DINDFG = U.S. feed grain use by industry (computed from DDFG and DLVKFG)

DKFORFGE = Quarterly change in U.S. farmer owned reserve of feed grain (computed from KFORFGE)

DLVKFG = U.S. feed and residual of feed grains (corn, sorghum, oats, barley)-- million metric tons (Feed: Outlook and Situation Report)

DMYPIK = Dummy variable for PIK Program, 1 if third or fourth quarter of 1983, 0 if not

DRSI = Feed grain program interest rate subsidy (computed from RS and ICC)

EXR = Exchange rate, trade weighted index in dollars per unit of foreign currency, 1972 = 1.00

GNPD = GNP price deflator from the Fair model

ICCC = Interest rate charged for CCC non-recourse loans in percent (Feed: KCCCFGE = Ending feed grain stocks under CCC loan, million metric tons (U.S. Agricultural Stabilization and Conservation Service))

KFORFGE = U.S. ending farmer owned reserve stocks of feed grains, million metric tons (U.S. Agricultural Stabilization and Conservation Service)

KGOVFGE = Ending government owned feed grain stocks (total CCC inventory), million metric tons (U.S. Agricultural Stabilization and Conservation Service) Outlook & Situation Report)

KMKTFGE = U.S. ending market inventory of feed grain (computed from KPRIFGE and KCCCFGE)

KPRIFGE = U.S. free ending stocks of feed grains, million metric tons (U.S. Agricultural Stabilization and Conservation Service)

KPRISBE = U.S. ending free soybean stocks, million metric tons

N = Population

PAFC = U.S. average price of corn at farm in dollars per bushel (Feed: Outlook & Situation Report) Q1 = January-March, Q2 = April-May, Q3 = June-September, Q4 = October-December

PAFCFR = Real difference in the U.S. corn price and the corn support price (computed from PAFC, SPRC, and GNPD)

PAFS = Soybeans, price at farm, U.S. average in dollars per bushel (Oil Crops: Outlook & Situation Report) Q1 = January-March, Q2 = April-May, Q3 = June-September, Q4 = October-December

PAFSG = Sorghum, price at farm, U.S. average in dollars per bushel (Livestock & Poultry: Outlook & Situation Report) Q1 = January-March, Q2 = April-May, Q3 = June-September, Q4 = October-December

PBEEF = Average retail price of choice beef in cents per pound (Livestock & Poultry: Outlook & Situation Report) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December

PBR = Average retail price in 4-regions of broilers in cents per pound ((Livestock & Poultry: Outlook & Situation Report) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December

PCDBEEF = Per capita disappearance of carcass weight of beef in pounds (Livestock & Poultry: Outlook & Situation Report, Supply & Utility Table)

PCDBEEF = Per capita beef consumption (computed from PCDBEEF, N, and POP)

PCDBR = Per capita civilian disappearance of young chickens in pounds (Livestock & Poultry: Outlook & Situation Report)

PCDBR = Per capita broiler consumption (computed from PCDBR, N, and POP)

PCDPORK = Per capita disappearance of carcass weight of pork in pounds (Livestock & Poultry: Outlook & Situation Report)

PCDPORK = Per capita pork consumption (computed from PCDPORK, N, and POP)
 PCX = Real border price of corn (computed from PAFC, EXR, and GNPD)
 PF = U.S. GNP price deflator for nonfarm total sales using 1982 dollars from the Fair model
 PIGC = Pig crop for 10-states, 1,000 head (*Livestock & Poultry: Outlook & Situation Report*, Mar, May, Jul, Oct) Q1 = December-February, Q2 = March-May, Q3 = June-August, Q4 = September-November
 PIGOF = Pigs on feed (computed from PIGC) PMEAT = Weighted price of meat (computed from PBEEF, PPORK, and PBR)
 POP = U.S. noninstitutional population over 16 years in millions from the Fair model
 PPORK = Average retail price pork in cents per pound (*Livestock & Poultry: Outlook & Situation Report*) Q1 = January-March, Q2 = April-June, Q3 = July-September, Q4 = October-December
 PRDBEEF = Commercial production of beef, million rounds (*Livestock & Poultry: Outlook & Situation Report*, Supply & Util. Table)
 PRDBR = Total production of young chicken, million pounds (*Livestock & Poultry: Outlook & Situation Report*)
 PRDFG = U.S. production of feed grains (corn, sorghum, oats, barley), million metric tons (*Feed: Outlook and Situation Report*) PRDFGA = Annual moving average feed grain production (computed from PRDFGT) PRDFGT = Annualized feed grain production in the fourth quarter (computed from Q4 and PRDFG)
 PRDPORK = Commercial production of pork, million pounds (*Livestock & Poultry: Outlook & Situation Report*)
 PRDSH = U.S. production of soybeans, million metric tons
 PRDSH = U.S. production of soybeans (computed from KPRISBE, XSB, and CRUSH)
 PSX = Real border price of soybeans (computed from PAFS, EXR, and GNPD)
 Q1 = Quarterly dummy variable for first quarter
 Q2 = Quarterly dummy variable for second quarter
 Q3 = Quarterly dummy variable for third quarter
 Q4 = Quarterly dummy variable for fourth quarter
 RELFORC = Release price for the farmer owned reserve corn in dollars per bushel (*Feed: Outlook & Situation Report*) RELOTH = Ratio of price of other goods to consumer income (computed from RPF and RPYD)
 RELPBEEF = Ratio of beef price to consumer income (computed from RPBEEF and RPYD)
 RELPBR = Ratio of broiler price to consumer income (computed from RPBR and RPYD)
 RELPPORK = Ratio of pork price to consumer income (computed from RPPORK and RPYD)
 RPAFC = Real U.S. corn price (computed from PAFC and GNPD) RPAFCBR = Corn-broiler price ratio (computed from PAFC and PBR)
 RPAFCMT = Ratio of corn price to the price of meat (computed from PAFC and PMEAT)
 RPAFS = Real U.S. soybean price (computed from PAFS and GNPD)
 RPAFSMT = Ratio of soybean price to the price of meat (computed from PAFS and PMEAT)
 RPBEEF = Real price of beef (computed from PBEEF and GNPD)
 RPBR = Real price of broilers (computed from PBR and GNPD)
 RPCPB = Ratio of corn price to the price of beef (computed from PAFC and PBEEF)

RPCPBR = Ratio of corn price to the price of broilers (computed from PAFC and PBR)
 RPCPP = Ratio of corn price to the price of pork (computed from PAFC and PPORK)
 RPF = PF/GNPD
 RPMEAT = Real price of meat (computed from PMEAT and GNPD)
 RPPORK = Real price of pork (computed from PPORK and GNPD)
 RPYD = Real disposable income per capita (computed from YD, GNPD, and POP)
 RRELFORC = Real release price for corn (computed from RELFORC and GNPD)
 RRS = Real interest rate (computed from RS and GNPD)
 RS = Three month U.S. Treasury-bill rate (percentage points) from the Fair model
 RSGP = Real U.S. federal deficit (computed from SGP and GNPD)
 RSPC = Real corn support price (computed from SPRC and GNPD)
 RSPCHIGH = Qualitative strength of corn support price (computed from RSPC, RPAFC, and COMPFG)
 RSPFORC = Real farmer owned reserve support price (computed from SPFORC and GNPD)
 RSPFORPC = Strength of corn government support (computed from RSPFFPC and KFORFGE)
 RSPFFPC = Ratio of support price for corn to the market price (computed from SPRC and PAFC)
 RWPRDFG = Feed grain production in the rest of the world (computed from WPRDFG and PRDFGA)
 SGP = U.S. federal deficit from the Fair model
 SPFORC = Support price for farmer owned reserve corn in dollars per bushel (Feed: Outlook & Situation Report)
 SPRC = Regular CCC support price of corn in dollars per bushel (Feed: Outlook & Situation Report)
 TCOWKE = Cows & heifers that have calved (cow inventory) in the U.S., 1,000 head (Livestock & Poultry: Outlook & Situation Report, Aug & Mar)
 Q1 = Average, Q2 = July 1, Q3 = Average, Q4 = January 1 of following year
 TIME = Quarterly time index with first quarter of 1980 = 320, second quarter of 1980 = 321, etc.
 TPBEEF = Real border price of beef (computed from RPBEEF and EXR)
 TPBR = Real border price of broilers (computed from RPBR and EXR)
 TPPORK = Real border price of pork (computed from RPPORK and EXR)
 WPRDFG = World production of feed grains (corn, sorghum, oats, barley), million metric tons (Corn: Background for 1985 Farm Legislation, Bulletin 471)
 XBR = Net U.S. exports of broilers (computed from PRDBR, PCDBR, and N)
 XFG = U.S. exports of feed grains (corn, sorghum, oats, barley), million metric tons (Feed: Outlook and Situation Report)
 XSB = U.S. exports of soybeans, million metric tons
 YD = U.S. disposable income in billion dollars from the Fair model
 YEAR = Two digit year
 LYR = LOG(YEAR)
 YRYR = YEARWYEAR

The explicit transformations made from basic data to obtain the computed variables used in econometric estimation are summarized explicitly in Table 2

for the variables with annual data and in Table 3 for the variables with quarterly data.

Using these variables, the following equations are estimated.

Annual Equations for the Feed Grain Supply Block

The feed grain supply block consists of a logistic equation that explains program participation, an equation that explains nonparticipating feed grain acreage and variation from program acreage (base acreage less minimum diversion requirements) on participating farms, an equation that represents feed grain yield, and an equation that explains how per acre costs of feed grain production respond to feed grain prices. The participation equation follows (6) with a dummy variable added to represent years when diversion was not required to receive program benefits. The acreage equation follows (5) with soybeans as the competing crop. The yield equation is a simple time trend modified to represent response of yields to diversion which presumably removes poorer acreage from production first. The cost equation specifies cost of production as a function of output price following the arguments of Gardner whereby the prices of inputs are bid up to exhaust rents.

Estimated Equation for LCOMPFGA

$$\text{LCOMPFGA} = .6884 + .02161 \text{ PROFFGC} - .02386 \text{ PROFFGN} - 7.364 \text{ NOPROG}$$

$$(.5078) \quad (.008614) \quad (.008234) \quad (.4601)$$

$$R^2 = .956, \quad R^2 = .949, \quad DW = 1.23, \quad \sigma_y = .8572, \quad \text{Data} = 1962:1 - 1987:1$$

Estimated Equation for ACGSN

$$\text{ACGSN} = 91.46 \text{ NON} + .01898 \text{ NONPROFC} - .04626 \text{ NONPROFS} + .1281 \text{ NONLAGA}$$

$$(30.37) \quad (.05186) \quad (.06921) \quad (.2842)$$

$$-.003978 \text{ BVDPFC}$$

$$(.0008560)$$

$$R^2 = .978, \quad R^2 = .973, \quad DW = 1.47, \quad \sigma_y = 6.104, \quad \text{Data} = 1962:1 - 1987:1$$

Estimated Equation for YLDCGS

$$\text{YLDCGS} = -68.03 + 1.856 \text{ YEAR} + .2320 \text{ DIV}$$

(16.23) (.2103) (.1929)

$R^2 = .774$, $R^2 = .754$, $DW = 2.23$, $\sigma_y = 7.805$, Data = 1962:1 - 1987:1

Estimated Equation for RCOSTCGS

RCOSTCGS = -14.45 + 1.011 YEAR + 18.53 RFPC
(23.19) (.2571) (2.423)

$R^2 = .722$, $R^2 = .698$, $DW = .951$, $\sigma_y = 9.077$, Data = 1962:1 - 1987:1

Annual Equations for the Soybean Supply Block

The soybean supply block has a structure similar to feed grains except that no participation equation is included since there has been no voluntary program. Hence, the acreage equation follows the free market form in (1). The yield equation follows a simple time trend with variations in response to feed grain diversion (which presumably removes poorer acreage from soybean as well as corn production) and the ratio of profit per acre for feed grain production to that for soybean production (representing the shift of higher quality land toward the more profitable crop).

Estimated Equation for AS

AS = -1.859 + .08838 PROFS - .07905 PROFFG + .9783 AS(T-1)
(2.401) (.01473) (.01681) (.03948)

$R^2 = .971$, $R^2 = .967$, $DW = 3.00$, $\sigma_y = 2.482$, Data = 1962:1 - 1987:1

Estimated Equation for YLDS

YLDS = -1.621 + .4072 YEAR - 2.811 RATIO + .07692 DIV
(4.405) (.06707) (1.867) (.04955)

$R^2 = .680$, $R^2 = .637$, $DW = 2.34$, $\sigma_y = 1.908$, Data = 1962:1 - 1987:1

Estimated Equation for RCOSTS

RCOSTS = -21.26 + .5249 YEAR + 5.973 RFPS
(14.21) (.1600) (.6522)

$R^2 = .786$, $R^2 = .767$, $DW = 1.50$, $\sigma_y = 5.849$, Data = 1962:1 - 1987:1

Quarterly Feed Grain Demand Block

For purposes of estimation, the demand for feed grains is broken into the demand for feed, industry, exports, farmer owned reserve, government owned stocks, and feed grain price which implicitly determines free stocks through an identity. Feed demand depends on cattle, hog, and broiler numbers since all three types of livestock are heavy users of corn as well as on the ratio of corn price to meat price. The specification of export and inventory equations follows the earlier discussion.

Estimated Equation for DLVKFG

$$\begin{aligned} \text{DLVKFG} = & 14.25 - 6.776 \text{ Q1} - 14.54 \text{ Q2} - 10.63 \text{ Q3} - 406.6 \text{ RPAFCMT} \\ & (10.53) \quad (1.638) \quad (2.759) \quad (2.140) \quad (170.7) \\ & + .001126 \text{ COF} + .0001552 \text{ PIGOF} + .000001684 \text{ BROF} \\ & \quad (.0006086) \quad (.0001591) \quad (.000004695) \\ & + .4622 \text{ DLVKFG(T-1)} \\ & \quad (.09593) \end{aligned}$$

$$R^2 = .937, \bar{R}^2 = .926, \text{DW} = 1.90, \sigma_y = 2.914, \text{Data} = 1973:1 - 1987:3$$

Estimated Equation for DDINDFG

$$\begin{aligned} \text{DDINDFG} = & -7.373 + .5827 \text{ Q1} - .1042 \text{ Q2} + .2549 \text{ Q3} - .1264 \text{ RPAFC} \\ & (5.800) \quad (.4309) \quad (.4317) \quad (.4334) \quad (.2524) \\ & + 2.518 \text{ RPYD} \\ & \quad (1.600) \end{aligned}$$

$$R^2 = .210, \bar{R}^2 = .136, \text{DW} = 2.18, \sigma_y = 1.159, \text{Data} = 1973:1 - 1987:3$$

Estimated Equation for XFG

$$\begin{aligned} \text{XFG} = & 1.473 - .3727 \text{ Q1} - 2.797 \text{ Q2} + 1.041 \text{ Q3} + .4605 \text{ XFG(T-4)} \\ & (3.182) \quad (.9574) \quad (1.106) \quad (.9665) \quad (.09736) \\ & - .9691 \text{ PCX} + 9.339 \text{ EXR} \\ & \quad (.4480) \quad (2.943) \end{aligned}$$

$$R^2 = .676, \bar{R}^2 = .639, \text{DW} = .922, \sigma_y = 2.556, \text{Data} = 1973:1 - 1987:3$$

Estimated Equation for CKFORFGE

$$\text{CKFORFGE} = -59.66 - 4.542 \text{ Q1} - 10.05 \text{ Q2} - 10.79 \text{ Q3} - 8.889 \text{ RPAFC}$$

$$(22.20) \quad (3.175) \quad (3.118) \quad (3.145) \quad (2.430)$$

$$+ 15.88 \text{ RRELFORC} + 17.01 \text{ RSPFORC} - 1.234 \text{ DRSI} - 24.85 \text{ DMYPIK}$$

$$(10.17) \quad (8.451) \quad (.7232) \quad (5.005)$$

$$R^2 = .704, \bar{R}^2 = .623, \text{DW} = 2.45, \sigma_y = 6.458, \text{Data} = 1978:2 - 1987:3$$

Estimated Equation for KGOVFGE

$$\text{KGOVFGE} = .1277 - .3869 \text{ Q1} + 1.389 \text{ Q2} + .3985 \text{ Q3} + .5176 \text{ KGOVFGE}(T-1)$$

$$(.9858) \quad (1.325) \quad (1.336) \quad (1.276) \quad (.06948)$$

$$+ .07412 \text{ RSPFORPC} + 18.39 \text{ DMYPIK} + 38.84 \text{ RSPCHIGH}$$

$$(.0342) \quad (2.992) \quad (4.998)$$

$$R^2 = .933, \bar{R}^2 = .924, \text{DW} = 1.49, \sigma_y = 3.397, \text{Data} = 1973:1 - 1987:3$$

Estimated Equation for RPAFC

$$\text{RPAFC} = 2.370 - .05076 \text{ Q1} - .2600 \text{ Q2} - .3627 \text{ Q3} + .7008 \text{ RPAFC}(T-1)$$

$$(1.660) \quad (.2062) \quad (.2719) \quad (.3452) \quad (.08059)$$

$$- .005093 \text{ KMKTFGE} + .1781 \text{ EXR} - .00376 \text{ RWPRDFG} + .003661 \text{ RPMEAT}$$

$$(.002564) \quad (.5768) \quad (.00207) \quad (.003918)$$

$$R^2 = .901, \bar{R}^2 = .885, \text{DW} = 1.95, \sigma_y = .3494, \text{Data} = 1973:1 - 1987:3$$

Estimated Equation for PAFSG

$$\text{PAFSG} = 1.616 \text{ PAFC}$$

$$(.009685)$$

$$R^2 = .968, \bar{R}^2 = .966, \text{DW} = .918, \sigma_y = .1904, \text{Data} = 1970:1 - 1987:3$$

Quarterly Soybean Demand Block

The soybean demand block contains equations for exports, crushings, and price with inventory determined implicitly by a supply-demand identity. The structure of the export equation is essentially the same as for feed grains. Crushings are determined by livestock numbers reflecting the feed use of soybean meal and consumer income reflecting demand for soybean oil.

Estimated Equation for XSB

$$\begin{aligned} \text{XSB} = & 377.7 - 102.5 \text{ Q1} - 166.3 \text{ Q2} - 142.8 \text{ Q3} + .3496 \text{ XSB(T-4)} \\ & (74.96) \quad (20.90) \quad (17.05) \quad (12.21) \quad (.1195) \\ & - 13.55 \text{ PSX} - 13.18 \text{ EXR} - 8.892 \text{ NONUSS} \\ & (3.313) \quad (47.30) \quad (4.258) \end{aligned}$$

$$R^2 = .838, \quad R^2 = .816, \quad \text{DW} = 2.07, \quad \sigma_y = 32.58, \quad \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for CRUSH

$$\begin{aligned} \text{CRUSH} = & 132.1 - 62.37 \text{ Q1} - 72.25 \text{ Q2} - 30.66 \text{ Q3} + .4891 \text{ CRUSH(T-1)} \\ & (142.4) \quad (14.78) \quad (38.38) \quad (36.82) \quad (.1823) \\ & + .01582 \text{ COF} + .004419 \text{ PIGOF} - .0001748 \text{ BROF} - 18.31 \text{ RPAFS} \\ & (.005544) \quad (.002090) \quad (.0001437) \quad (5.665) \\ & + 19.60 \text{ RPYD} \\ & (59.67) \end{aligned}$$

$$R^2 = .910, \quad R^2 = .894, \quad \text{DW} = 1.75, \quad \sigma_y = 25.25, \quad \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for RPAFS

$$\begin{aligned} \text{RPAFS} = & 5.833 - 2.029 \text{ Q1} - 1.658 \text{ Q2} - 2.741 \text{ Q3} + .2257 \text{ RPAFS(T-1)} \\ & (3.563) \quad (.7850) \quad (1.184) \quad (1.664) \quad (.1101) \\ & + .0004466 \text{ COF} + .2247 \text{ PIGOF} - .000006121 \text{ BROF} - .1134 \text{ RRS} \\ & (.0001898) \quad (.00007176) \quad (.000002598) \quad (.09747) \\ & - .09715 \text{ NONUSS} - .003688 \text{ KPRISBE} \\ & (.1467) \quad (.001298) \end{aligned}$$

$$R^2 = .863, \quad R^2 = .835, \quad \text{DW} = 1.98, \quad \sigma_y = 1.128, \quad \text{Data} = 1973:1 - 1987:4$$

Quarterly Meat Supply Block

The structure of the meat supply block follows the earlier generic discussion with breeding herd, numbers on feed, production, and import/export equations included for cattle, hogs, and poultry. The beef supply component of the meat supply block includes the following estimated equations.

Estimated Equation for CCOWKE

$$\begin{aligned} \text{CCOWKE} = & -555.4 + 769.0 \text{ Q1} + 749.4 \text{ Q2} + 13.78 \text{ Q3} - 101.4 \text{ RPCPB} \\ & (372.3) \quad (193.5) \quad (193.2) \quad (193.3) \quad (24470.) \\ & - 55.94 \text{ RRS} + 68.37 \text{ RRS(T-1)} \\ & (62.41) \quad (59.72) \end{aligned}$$

$$R^2 = .376, R^2 = .306, DW = .473, \sigma_y = 528.5, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for PRDBEEF

$$\text{PRDBEEF} = 5005. + 132.6 Q1 - 3.275 Q2 - 30.32 Q3 + .04418 \text{CATPL} \\ (536.8) (113.7) (185.7) (99.21) (.08028)$$

$$- .4125 \text{CCOWKE} + 34570. \text{RPCPB} \\ (.07123) (11990.)$$

$$R^2 = .516, R^2 = .462, DW = .915, \sigma_y = 269.6, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for COF

$$\text{COF} = 2001. + .8013 \text{CATFL} + .4183 \text{CATPL}(T-1) \\ (473.6) (.05088) (.05105)$$

$$R^2 = .873, R^2 = .867, DW = 1.00, \sigma_y = 300.3, \text{Data} = 1976:1 - 1986:3$$

Estimated Equation for CATPL

$$\text{CATPL} = 3968. - 1743. Q1 - 1514. Q2 - 1298. Q3 - .09603 \text{TCOWKE} \\ (1116.) (165.2) (163.1) (162.7) .02569)$$

$$- 146900. \text{RPCPB} \\ (23680.)$$

$$R^2 = .790, R^2 = .770, DW = 1.59, \sigma_y = 442.1, \text{Data} = 1973:2 - 1987:4$$

The pork supply component of the meat supply block includes the following estimated equations.

Estimated Equation for BRHOGKE

$$\text{BRHOGKE} = 759.2 - 49.00 Q1 + 120.0 Q2 - 170.5 Q3 + .9509 \text{BRHOGKE}(T-1) \\ (252.6) (73.34) (73.18) (73.49) (.0395)$$

$$- 23590. \text{RPCPP} - 32.26 \text{RRS} \\ (6156.) (9.361)$$

$$R^2 = .925, R^2 = .916, DW = 1.74, \sigma_y = 200.3, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for PRDPORK

$$\text{PRDPORK} = 864.9 + 116.2 Q1 + 121.6 Q2 + 203.4 Q3 + .1455 \text{PIGC} \\ (367.9) (81.17) (76.51) (119.1) (.01917)$$

$$- .1016 \text{CBRHOGKE} + 2403. \text{RPCPP} + 34.70 \text{RRS} \\ (.1176) (5975.) (10.21)$$

$$R^2 = .826, R^2 = .802, DW = 1.41, \sigma_y = 171.1, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for PIGC

$$\text{PIGC} = 9686. - 2041. Q1 + 2855. Q2 + 248.6 Q3 + 1.645 \text{ BRHOGKE} - 181600. \text{RPCPP}$$

(1500.) (455.7) (458.8) (456.6) (.2708) (40230.)

$$R^2 = .739, R^2 = .714, DW = .735, \sigma_y = 1239., \text{Data} = 1973:1 - 1987:4$$

The poultry component of the meat supply block includes the following estimated equations.

Estimated Equation for PRDBR

$$\text{PRDBR} = -800.0 + 148.6 Q1 + 148.1 Q2 - 124.8 Q3 + .003463 \text{ BRCH}$$

(115.3) (28.68) (28.28) (29.08) (.00007286)

$$+ 570.7 \text{ RPCPBR}$$

(1511.)

$$R^2 = .984, R^2 = .983, DW = 1.03, \sigma_y = 77.43, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for CPL

$$\text{CPL} = 3981. - 103.0 Q1 + 357.0 Q2 - 1040. Q3 + .7616 \text{ CPL}$$

(919.2) (216.5) (219.5) (226.2) (.06795)

$$- 41080. \text{RPCPBR}$$

(11460.)

$$R^2 = .846, R^2 = .832, DW = 2.44, \sigma_y = 591.1, \text{Data} = 1973:1 - 1987:4$$

Estimated Equation for BRCH

$$\text{BRCH} = -166900. + 50220. Q1 + 93450. Q2 + 40980. Q3 + 36.91 \text{ CPL}$$

(98360.) (27050.) (26110.) (27430.) (13.25)

$$+ 14.79 \text{ CPL}(T-1) + 22.25 \text{ CPL}(T-2) + 20.55 \text{ CPL}(T-3)$$

(13.64) (13.69) (13.72)

$$+ 21.75 \text{ CPL} - 745100. \text{RPCPBR}$$

(11.92) (1173000.)

$$R^2 = .921, R^2 = .906, DW = .246, \sigma_y = 538300., \text{Data} = 1973:1 - 1987:4$$

Quarterly Meat Demand Block

The meat demand block includes two components of estimated equations. The domestic meat demand component of the meat demand block forms a simultaneous multivariate system where each demand equation is represented in

price dependent form with each demand depending on the prices of the other two meat types and the price of all other goods. Consumer income is included and homogeneity is imposed by expressing all prices relative to consumer income.

Estimated Equation for RPBEEF

$$\begin{aligned} \text{RPBEEF} = & 105.3 - 3.602 Q1 + .5536 Q2 + 4.794 Q3 + 5.680 \text{REL PBR} \\ & (59.97) \quad (5.686) \quad (5.691) \quad (5.657) \quad (1.015) \\ & + .08101 \text{REL PPORK} + 765.7 \text{RELOTH} - 7.268 \text{PCDBEEF} \\ & (.5032) \quad (241.9) \quad (.9613) \end{aligned}$$

$$R^2 = .751, \bar{R}^2 = .714, DW = .721, \sigma_y = 14.86, \text{Data} = 1974:1 - 1987:4$$

Estimated Equation for RPPORK

$$\begin{aligned} \text{RPPORK} = & 257.2 - 11.77 Q1 - 16.69 Q2 - 16.80 Q3 + 3.130 \text{REL PBR} \\ & (35.11) \quad (3.060) \quad (3.185) \quad (3.307) \quad (.3769) \\ & + .9091 \text{REL PBEF} - 186.3 \text{RELOTH} - 7.589 \text{PCDPORK} \\ & (.2020) \quad (142.1) \quad (.7508) \end{aligned}$$

$$R^2 = .923, \bar{R}^2 = .911, DW = .981, \sigma_y = 7.730, \text{Data} = 1974:1 - 1987:4$$

Estimated Equation for RPBR

$$\begin{aligned} \text{RPBR} = & 344.6 + 2.379 Q1 + 8.387 Q2 + 8.372 Q3 + .3590 \text{REL PBEF} \\ & (25.44) \quad (1.112) \quad (1.258) \quad (1.235) \quad (.05903) \\ & + .5151 \text{REL PPORK} - 785.9 \text{RELOTH} - 6.427 \text{PCDBR} \\ & (.07357) \quad (71.40) \quad (.4993) \end{aligned}$$

$$R^2 = .958, \bar{R}^2 = .951, DW = 1.88, \sigma_y = 2.927, \text{Data} = 1974:1 - 1987:4$$

The meat trade component of the meat demand block consists of three equations explaining the net imports (exports) of beef, pork, and poultry.

Estimated Equation for MBEEF

$$\begin{aligned} \text{MBEEF} = & 39.15 + 136.0 Q1 + 99.67 Q2 + 149.0 Q3 + .7265 \text{TPBEEF} \\ & (73.43) \quad (42.01) \quad (38.54) \quad (38.45) \quad (.3181) \\ & + .4309 \text{MBEEF}(T-1) \\ & (.1370) \end{aligned}$$

$$R^2 = .517, \bar{R}^2 = .469, DW = 2.02, \sigma_y = 99.82, \text{Data} = 1974:1 - 1987:4$$

Estimated Equation for MPORK

$$\text{MPORK} = 211.8 + 105.9 \text{ Q1} + 44.49 \text{ Q2} + 165.1 \text{ Q3} - 229.2 \text{ EXR}$$

(95.63) (23.21) (20.80) (22.85) (76.96)

$$+ .5264 \text{ MPORK(T-1)}$$

(.1182)

$$R^2 = .736, \bar{R}^2 = .710, \text{DW} = 2.25, \sigma_y = 50.68, \text{Data} = 1974:1 - 1987:4$$

Estimated Equation for XBR

$$\text{XBR} = 21.53 + 12.23 \text{ Q1} + 17.62 \text{ Q2} + 22.01 \text{ Q3} - 1.176 \text{ TPBR}$$

(56.51) (14.86) (14.81) (14.81) (.7373)

$$+ 115.5 \text{ EXR} + .6010 \text{ XBR(T-1)}$$

(105.0) (.1287)

$$R^2 = .601, \bar{R}^2 = .552, \text{DW} = 2.40, \sigma_y = 38.79, \text{Data} = 1974:1 - 1987:4$$

Quarterly Exchange Rate Model

The exchange rate equation is a simple partially reduced form equation designed to reflect the effects on exchange rates of major changes in macroeconomic policy. Since the major macroeconomic policies of interest are monetary and fiscal policy, the two variables most commonly used as measures of the corresponding effects are included -- the real interest rate and the federal deficit.

Estimated Equation for EXR

$$\text{EXR} = .1923 - .01144 \text{ Q1} - .007962 \text{ Q2} - .007129 \text{ Q3} + .8346 \text{ EXR(T-1)}$$

(.0568) (.01022) (.010161) (.010157) (.0513)

$$- .003491 \text{ RRS} - .0007997 \text{ RSGP}$$

(.001389) (.0002767)

$$R^2 = .951, \bar{R}^2 = .946, \text{DW} = 1.63, \sigma_y = .02687, \text{Data} = 1973:1 - 1986:4$$

Identities

The grain model is closed by production (production is equal to the product of acreage and yield) and supply-demand identity equations for each of the grain commodities.

Identities for feed grains

$$PRDFG = AFGWYLDG$$

$$PRDFG + KMKTFGE(T-1) + KFORFGE(T-1) + KGOVFGE(T-1) \\ = DINDFG + DLVKFG + XFG + KMKTFGE + KFORFGE + KGOVFGE$$

Identities for soybeans

$$PRDSH = ASWYLDG$$

$$PRDSH + KPRISBE(T-1) = CRUSH + XSB + KPRISBE$$

The meat model is closed by supply-demand identity equations for each of the meats which equate production plus net imports to the product of per capita consumption and population.

Identity for beef

$$PRDBEEF + MBEEF = PCDBEEFWPOP$$

Identity for pork

$$PRDPORK + MPORK = PCDPORKWPOP$$

Identity for broilers

$$PRDBR - XBR = PCDBRWPOP$$

Model Validation

Model validation is an important step in demonstrating the usefulness of a policy model. Typical validation procedures here reveal that the USAGMKTS model performs acceptably. First, the model can reproduce historically observed data quite well. This validation step was done by simulating the model over the estimation period for each equation in the model (where lagged

endogenous variables are evaluated at their predicted rather than actual values). The simulated values of endogenous variables and their actual historical values are plotted together over the respective estimation periods in the Appendix. In general, simulated values track historical values quite well. Based on these results and the estimation statistics reported above, the USAGMKTS model appears to provide a sufficient basis for simulating U.S. agricultural policy effects on corn, sorghum, and soybean markets.

Estimated Policy Sensitivity

The remainder of this report turns to examination of the estimated sensitivity of agricultural prices and trade to agricultural policy instruments. Using the model discussed above, several policy alternatives are simulated to determine the effects of major changes in farm commodity programs on the farm level prices of corn, sorghum, soybeans, beef, pork, and broilers. The policy alternatives considered are as follows:

1. A reduction of 10 percent in price supports for feed grains (with corresponding changes in price controls for the farmer owned reserve).
2. An increase of 10 percent in price supports for feed grains.
3. A reduction of 10 percent in both price supports and target prices for feed grains.
4. An increase of 10 percent in both price supports and target prices for feed grains.
5. A reduction of the diversion requirement by 10 percent.

These various alternatives are investigated by simulating the changes for two years beginning first with the 1981 crop year and then with the 1984 crop year. A period of two years was chosen because the policy changes do not affect production until late in the first year. Thus, the first year effects are largely an indication of how markets are affected holding production fixed

while the second year suggests how markets are affected after production effects are realized. While the model has the complexity to estimate dynamic effects over a much longer period of time, the U.S. agricultural policy arena is a rapidly changing one. Thus, a relatively short period for policy analysis is appropriate and helpful in simplifying the presentation and discussion below.

In each case, the results are summarized by arc elasticities which indicate the percentage response in agricultural prices and trade associated with a one percent adjustment in the level of the policy instrument. The 1983 crop year was not used for these purposes because of peculiarities associated with the one-time payment-in-kind (PIK) program effectuated in that year. The adjustment of target and support prices is investigated in both directions because the qualitative nature of the model possibly generates different types of changes in different directions.

While the model and its estimated responses are generated on a quarterly basis, the results are summarized by annual averages in the results discussed here. Tables 4 and 5 give the estimated elasticities of policy response averaged over the first year and the second year following a policy change instituted in the context of the agricultural economy as it existed in 1981 and 1982. Price responsiveness is investigated in Table 4 and trade responsiveness is investigated in Table 5.

The results in Table 4 show that feed grain prices are heavily dependent on government price controls. Corn and sorghum prices tend to rise by about three-quarters of any rise in support or in support and target prices in the first year. In the second year, the rise is substantially greater. For example, a 10 percent change in the support price causes about a 15 percent change in the market price. The reason for the sharper response in the second

year in this simulation is that market prices had fallen below support prices in 1982 while they were still somewhat above support levels in 1981 in actual history. Thus, the model reflects the kind of kinked response that occurs as market prices reach support levels. The reason why the elasticity of price response in the second year can be greater than 1.0 is that a higher level of support can induce more program participation with the resulting increase in compliance causing a reduction in supply which creates a further upward pressure on price.

The impact of these changes on soybean price is initially a small decline associated with the decrease in demand for livestock feeding motivated by higher feed grain prices. By the second year, the higher feed grain target prices cause substitution of feed grain acreage for soybean acreage which then transmits the upward tendency in prices to the soybean market through reduced soybean supply. This effect does not occur, however, if only the support price and not the target price is increased because the support price is primarily a market price instrument affecting storage while the target price is a production incentive with strong indirect effects on competing acreages. While the associated elasticities are smaller than for the direct effects on feed grain prices, the effects on soybean prices in the second year which include effects of changing target prices are not negligible. For example, the elasticity of .2 for soybeans in the case of a 10 percent support and target price increase means that a \$.24 per bushel increase in corn price is accompanied by a \$.12 per bushel increase in soybean price during the second year.

The effect on the price of meats is an increase which occurs as a result of reduced supply in response to higher feed prices. Initially, this effect is small because inventories are slow to adjust and feeding commitments have

already been made. These effects get larger in the second year as these adjustments occur. The effects on poultry are the largest and fastest because the production cycle is shorter and, therefore, quicker to adjust. Pork price effects are larger and faster than for beef for the same reason.

While the estimated effects of the feed grain diversion requirement in Table 4 appear to be small, one must bear in mind the structural role that the diversion requirement plays. The first year effects of a change in the diversion requirement are negligible because diversion has effects only through production which does not occur until near the end of the first year. Additionally, the diversion requirement only affects a proportion of acreage corresponding to the feed grain program participation rate.

The participation rate in the feed grain program was essentially ineffectual in 1981 and was only 31.9 percent in 1982. Thus, the effect of cutting the diversion requirement by 10 percent on all participating farms would only be an increase in total acreage of 3.2 percent even if the participation rate is held constant and no slippage (compensating acreage reduction on nonparticipating farms) occurs. In reality, a reduction in the diversion requirement would induce increased participation which would reduce acreage as more farms come into compliance. In addition, slippage occurs as farms that continue not to participate compensate by reducing acreage in response to the increased acreage on participating farms and its expected effects on the free market. Thus, the estimated effect of a 10 percent reduction in the diversion requirement in the second year on feed grain prices of about a 0.9 percent reduction in price is plausible. The same holds for the associated effects in other markets which are also negligible.

Turning to Table 5, the effects of policy agricultural policy adjustment on trade appear to be smaller. For example, a 10 percent adjustment in the

feed grain support (and target) prices causes less than a one percent change in exports in the first year and only about a 3 percent change in the second year. The reason for the small effect in the first year is that production cannot respond until near the end of the first year. Nevertheless, the second year results suggest that the equilibrium price elasticity of export demand is only about $-.2$ (a three percent change in exports divided by a fifteen percent change in market price). Note that this equilibrium elasticity is somewhat lower than most estimated partial elasticities of export demand in the literature as it should be.

It suffices to say that most of the export quantity effects of price policy instruments on other commodities are minor. Higher feed grain prices cause reduced feeding which reduces domestic demand for soybeans somewhat and channels more soybeans into export markets. If feed grain target prices are increased, however, the shift of producing acreage from soybeans to feed grains in the second year discussed above can cause a decline in soybean exports.

While some of the elasticities for meat trade approach 1.0, one must bear in mind that the quantity of meat trade is minor by comparison to feed grains. Higher feed grain prices cause a decline in domestic meat supply which results in more beef and pork imports and less poultry exports. The response for poultry is again largest in percentage terms because of the shorter production cycle.

The last column of Table 5 reveals that the diversion requirement has relatively minor effects on exports. As with effects on prices, the first year effects are small because diversion does not affect production until near the end of the first year. The second year effects on feed grain markets are small because the diversion effects on prices are small and any diversion

reduction is partially offset by increased program participation which induces more farmers to plant within the bounds of the program.

Tables 6 and 7 parallel Tables 4 and 5 but give the results of beginning the simulations in 1984 instead of 1981. The qualitative nature and explanation of these results is the essentially the same as for Tables 4 and 5. However, the quantitative differences are interesting and illustrate how responsiveness to policy instruments changes as the state of the agricultural economy changes.

The major difference in results is for the effect of the diversion requirement. The reason for the much larger effects in Tables 6 and 7 is that the level of participation is much higher in 1984 and 1985 than in 1981 and 1982 (an average of 59 percent versus 16 percent across the corresponding two year periods). At a higher participation level, the change in diversion requirement directly affects acreage on more farms. These results show that the diversion requirement can have a large effect on prices when the participation rate is high. By the second year when production effects are realized, a 10 percent diversion reduction results in a 6 percent decline in feed grain prices. Lower feed prices then lead to more feeding, more demand for complementary feed ingredients which causes higher demand and price for soybeans (about 2.5 percent higher price), and more meat supply which causes reduced meat prices (about 0.7-1.7 percent lower meat prices).

The effects of a 10 percent reduction in the diversion requirement on trade are again small (see Table 7). Feed grain exports increase by 1.3 percent as a result of the 6 percent decline in feed prices (again suggesting an equilibrium elasticity for exports in the neighborhood of $-.2$). The 2.5 percent rise in price of soybeans results in a 1.6 percent decline in soybean exports. Effects on meat trade are small except for poultry where exports

increase by 2.4 percent but even here the quantitative magnitude of the effect is small.

The remaining effects in Tables 6 and 7 are similar although price effects are somewhat less and trade effects are somewhat more than the estimated effects in Tables 4 and 5. The reason for this difference appears to be that market prices were somewhat lower relative to support prices in 1984-85 than in 1981-82. As a result, prices in the simulated policy alternatives tend to stick more closely to the regulated support levels and, thus, more nearly reflect the percentage change in the support level.

Summary

This study reports the specification and estimation of a model of U.S. corn, sorghum, and soybeans (USAGMKTS) that includes the role of U.S. agricultural policies affecting the corresponding markets. To capture the dynamic effects of policy changes, markets are also included for cattle, hogs, and poultry. The results of estimation and validation appear plausible. Subsequent simulation of various alternative U.S. agricultural policy scenarios is used to estimate the effects of various feed grain policy instruments. The results show that these policy instruments have substantial effects on U.S. agricultural prices which face trading nations such as Mexico. Plausible U.S. agricultural policy adjustments can cause border prices facing world trading partners to be altered by 10 to 15 percent. However, the extent of these adjustments depends heavily on the current state of the U.S. agricultural economy in which they are instituted. These effects are further transmitted to other grain and livestock markets to varying extents. Thus, consideration of alternatives for adapting to new U.S. agricultural policy regimes appears to be a nontrivial but worthwhile activity for closely related countries such as Mexico.

Table 1. The Performance of Structural Versus Ad Hoc Models: The Case of U.S. Feed Grain Acreage^a

Model Definition (Equation)	Estimation Period	Forecast Period	Standard Error Within Sample (million acres)	Standard Error Post-Sample (million acres)
(9)	1962-82	1983-87	1.73	6.40
(5)	1962-82	1983-87	6.26	6.38
(5), (6)	1962-82	1983-87	^b	5.50

^a See the text for equations which define the various models.

^b No within sample error is computed since the model is derived by combining the estimated equations corresponding to (5) and (6).

Table 2. Transformations of Annual Data Used in the Model

MAXRATE	= .01WRS - .01WICCCA; IF MAXRATE<0 THEN MAXRATE = 0
ACGS	= AC+AGS
BACGS	= BAC+BAGS
EYLDCGS	= (YLDCGYST-3)+YKDCGS(T-2)+YLDCGS(T-1))/3
EYLDS	= (YLDS(T-3)+YLDS(T-2)+YLDS(T-1))/3
MAXYLDFG	= EYLDCGS - YLDFGP; IF MAXYLDFG<0 THEN MAXYLDFG = 0
MTPC	= TPC; IF MTI <PAFC1 THEN MTPC = PAFC1
MSPC	= SPRCA; IF MSPC<PAFC1 THEN MSPC = PAFC1
COSTCGS	= COSTCW(AC/ACGS) + COSTGSW(AGS/ACGS)
RCOSTCGS	= COSTCGS/GNPD
RCOSTS	= COSTS/GNPD
PROFFGN	= (PAFC1WEYLDCGS - COSTCGS)/GNPD
RETFGP	= MTPCWYLDFGP+MSPCWMAXYLDFG+MAXRATEWSPRCWEYLDCGS-COSTCGS
RVOL	= VDPC; IF RVOL<RETFGP THEN RVOL = RETFGP
PROFFGC	= ((1-DRFG-VDFG)WRETFGP+VDFGWRVOL+DPCWDRFG)/GNPD
PROFS	= (PAFS1WEYLDS - COSTS)/GNPD
PROFFG	= (1-COMPFGA)WPROFFGN + COMPFGAWPROFFGC
LCOMPFGA	= LOG((.001+COMPFGA)/(1-COMPFGA))
DIV	= COMPFGAWDRFGWBACGS
RATIO	= PROFFG/PROFS
NON	= 1-COMPFGA
NONPROFC	= PROFFGNW(1-COMPFGA)
NONPROFS	= PROFSW(1-COMPFGA)
NONLAGA	= (ACGS(T-1)+DIV(T-1))W(1-COMPFGA)
ACGSN	= ACGS-BACGSWCOMPFGAW(1-DRFG)
BVDPC	= VDPCWVDFGWBACGS/GNPD

Table 3. Transformations of Quarterly Data Used in the Model

TIME	= YRW4+Q2+Q3W2+Q4W3
RPYD	= YD / (GNPDWPOP)
RSGP	= SGP / GNPD
RPAFCBR	= PAFC / PBR
DRSI	= RS - ICC
RRS	= RS - (GNPD - GNPD (T-4)) / GNPD (T-4) W100
PCX	= PAFC / (EXRWGNPD)
PRDFGT	= Q4W (PRDFG (T-1) + PRDFG)
PRDFGA	= PRDFGT + PRDFGT (T-1) + PRDFGT (T-2) + PRDFGT (T-3)
RWPRDFG	= WPRDFG (T-3) - PRDFGA
KMKTFGE	= KPRIFGE + KCCCFGE
DINDFG	= DDFG - DLVKFG
RPAFC	= PAFC / GNPD
PAFCFR	= (PAFC - SPRC) / GNPD
RSPFPC	= SPRC / PAFC
DDINDFG	= DINDFG - DINDFG (T-4)
DKFORFGE	= KFORFGE - KFORFGE (T-1)
RRELFORC	= RELFORC / GNPD
RSPFORC	= SPFORC / GNPD
RSPFORPC	= RSPFPCWKFORFGE (T-1)
RSPC	= SPRC / GNPD
RSPCHIGH	= (RSPCW1.1 - RPAFC.GE.0) W (RSPCW1.1 - RPAFC) WCOMPFG (T-3)
PRDSH	= KPRISBE - KPRISBE (T-1) + XSB + CRUSH
PSX	= PAFS / (EXRWGNPD)
PCX	= PAFC / (EXRWGNPD)
RPAFSMT	= PAFS / PMEAT
RPAFS	= PAFS / GNPD
RPCPBR	= PAFC / PBR
RPCPB	= PAFC / PBEEF
RPCPP	= PAFC / PPORK
PIGOF	= PIGC (T-1) + PIGC (T-2)
BROF	= BRCH (T-1)
PMEAT	= .37WPBEEF + .12WPBR + .51WPPORK
RPMEAT	= PMEAT / GNPD
RPAFCMT	= PAFC / PMEAT
CCOWKE	= TCOWKE - TCOWKE (T-1)
CBRHOGKE	= BRHOGKE - BRHOGKE (T-1)
RPBEEF	= PBEEF / GNPD
RPPORK	= PPORK / GNPD
RPBR	= PBR / GNPD
RPF	= PF / GNPD
RELPEEF	= RPBEEF / RPYD
RELPPORK	= RPPORK / RPYD
RELPR	= RPBR / RPYD
RELOTH	= RPF / RPYD
MBEEF	= PCDBEEFWN - PRDBEEF
MPORK	= PCDPORKWN - PRDPORK
XBR	= PRDBR - PCDBRWN
TPBEEF	= RPBEEF / EXR
TPPORK	= RPPORK / EXR
TPBR	= RPBR / EXR
PCDBEEF	= PCDBEEFWN / POP
PCDPORK	= PCDPORKWN / POP
PCDBR	= PCDBRWN / POP
YRYR	= YRWYR
LYR	= LOG (YR)

Table 4. Elasticities of Response of Major U.S. Agricultural Prices to Government Program Controls, 1981-82

Commodity Price	Policy Instrument(s)				
	10% Price Support Decrease	10% Price Support Increase	10% Support & Target Price Decrease	10% Support & Target Price Increase	10% Diversion Reduction
<u>First Year</u>					
Corn (PAFC)	.74	.75	.74	.76	.008
Sorghum (PAFSG)	.74	.75	.74	.76	.008
Soybeans) (PAFS)	-.05	-.06	-.03	-.01	-.015
Beef (PBEEF)	.05	.05	.05	.05	.000
Pork (PPORK)	.11	.11	.11	.11	.000
Broiler (PBR)	.19	.20	.19	.20	.000
<u>Second Year</u>					
Corn (PAFC)	1.59	1.50	1.60	1.51	.092
Sorghum (PAFSG)	1.59	1.50	1.60	1.51	.092
Soybeans) (PAFS)	-.08	.01	.11	.20	-.096
Beef (PBEEF)	.38	.38	.38	.38	.010
Pork (PPORK)	.62	.60	.62	.61	.016
Broilers (PBR)	.85	.82	.86	.82	.023

Table 5. Elasticities of Response of U.S. Agricultural Exports to Government Program Controls, 1981-82

	Policy Instrument (s)				
Export Commodity	10% Price Support Decrease	10% Price Support Increase	10% Support & Target Price Decrease	10% Support & Target Price Increase	10% Diversion Reduction
<u>First Year</u>					
Corn & Sorghum (XFG)	-.06	-.07	-.06	-.07	-.001
Soybeans (XSB)	.02	.02	.01	.01	.002
Beef (PBEEF)	.02	.02	.02	.02	.000
Pork (MPORK)	.00	.00	.00	.00	.000
Poultry (XBR)	-.05	-.05	-.05	-.05	.000
<u>Second Year</u>					
Corn & Sorghum (XFG)	-.26	-.30	-.27	-.30	-.015
Soybeans (XSB)	.04	.03	.00	-.02	.024
Beef (MBEEF)	.19	.20	.20	.20	.005
Pork (MPORK)	.00	.00	.00	.00	.000
Poultry (XBR)	-.77	-.90	-.77	-.90	-.022

* Elasticities are for net imports in the case of beef and pork and net exports in the case of all other commodities.

Table 6. Elasticities of Response of Major U.S. Agricultural Prices to Government Program Controls, 1984-85

Commodity Price	Policy Instrument(s)				
	10% Price Support Decrease	10% Price Support Increase	10% Support & Target Price Decrease	10% Support & Target Price Increase	10% Diversion Reduction
<u>First Year</u>					
Corn (PAFC)	.69	.70	.69	.71	.083
Sorghum (PAFSG)	.69	.70	.69	.71	.083
Soybeans) (PAFS)	-.05	-.05	.01	.01	-.034
Beef (PBEEF)	.03	.03	.03	.03	.000
Pork (PPORK)	.05	.06	.05	.06	.000
Broiler (PBR)	.08	.09	.08	.09	.000
<u>Second Year</u>					
Corn (PAFC)	1.20	1.33	1.20	1.34	.618
Sorghum (PAFSG)	1.20	1.33	1.20	1.34	.618
Soybeans) (PAFS)	-.01	-.03	.31	.31	-.249
Beef (PBEEF)	.25	.26	.26	.26	.072
Pork (PPORK)	.39	.40	.39	.40	.122
Broilers (PBR)	.55	.55	.55	.56	.174

Table 7. Elasticities of Response of U.S. Agricultural Exports to Government Program Controls, 1984-85

Export Commodity	Policy Instrument(s)				
	10% Price Support Decrease	10% Price Support Increase	10% Support & Target Price Decrease	10% Support & Target Price Increase	10% Diversion Reduction
<u>First Year</u>					
Corn & Sorghum (XFG)	-.11	-.12	.10	.12	-.015
Soybeans (XSB)	.33	.02	.01	.02	.011
Beef (MBEEF)	.01	.01	.01	.01	.000
Pork (MPORK)	.00	.00	.00	.00	.000
Poultry (XBR)	-.07	-.08	-.07	-.06	.000
<u>Second Year</u>					
Corn & Sorghum (XFG)	-.28	-.35	-.28	-.35	-.128
Soybeans (XSB)	.07	.07	-.12	-.13	.164
Beef (MBEEF)	.13	.13	.13	.13	.033
Pork (MPORK)	.00	.00	.00	.00	.000
Poultry (XBR)	-.80	-.96	-.80	-.13	-.243

* Elasticities are for net imports in the case of beef and pork and net exports in the case of all other commodities.

APPENDIX

The appendix illustrates the ability of the USAGMKTS model to track historical data. For this purpose, each equation of the model was simulated over the entire sample period (where lagged endogenous variables were evaluated at their predicted rather than actual values). The simulated values of endogenous variables and their actual historical values are plotted together over the respective estimation periods in the diagrams that follow.

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